Testimony of

Ernest J. Moniz

Under Secretary

U.S. Department of Energy

to the

Subcommittee on National Economic Growth,

Natural Resources, and Regulatory Affairs,

Committee on Government Reform and Oversight

June 24, 1998

Mr. Chairman and Members of the Committee:

Thank you for the opportunity to testify before your committee on the potential effects on the U.S. economy of meeting the Kyoto Protocol emissions targets and the implications for energy production.

The President's climate policy is directed at the twin goals of continued, vigorous economic growth and sustained quality of life for Americans. A robust technology development program and flexible market-based instruments will ensure the economic competitiveness that is the foundation of our economic vitality and will provide insurance against changes in our climate that may adversely affect our quality of life. Economic analysis suggests these goals can be achieved at modest cost with major attendant benefits. I will very briefly review the Administration's analysis to provide context and then focus on energy technology development, the responsibility of the Department of Energy in concert with the private sector, and a major focus of the first phase of the President's climate change program.

As the 21st century approaches, our nation faces many intertwined energy, economic, and environmental challenges. Over the next few years, we will: restructure U.S. electricity markets; implement new Federal and state clean air requirements; encounter a potentially volatile global energy market; face increased economic competition in the global market for clean energy technologies; and begin to confront the threat of global climate change. There are technology paths that can help meet all of these challenges and turn them into

opportunities. And DOE and its national laboratories are working diligently to make these a reality.

Research, development and accelerated use of energy efficiency and clean energy technologies, built upon a solid foundation of advanced science and basic research, are major parts of the solution. In fact, these technology paths are so important in meeting these challenges, that even without the concern for climate change, these investments have been and would continue to be wise national policy. This point was made last Fall by the President's Committee of Advisors on Science and Technology.

> " . many of the energy-technology improvements that would be attractive for [greenhouse gas reduction] also could contribute importantly to addressing some of the other energy-related challenges that lie ahead, including reducing dependence on imported oil; diversifying the U.S. domestic fuel and electricity supply systems; expanding U.S. exports of energy-supply and energy-end-use technologies and know-how; reducing air and water pollution from fossil fuel technologies; reducing the cost and safety and security risks of nuclear energy systems around the world; fostering sustainable and stabilizing economic development; and strengthening U.S. leadership in science and technology."

These technologies coupled with the use of market-based mechanisms can lower the cost of meeting our climate objectives.

Flexibility and the Kyoto Protocol

Last December, in Kyoto, Japan, the Parties to the Framework Convention on Climate Change agreed to a set of flexible measures that will govern the climate change mitigation efforts of nations. These flexibility provisions are firmly based on a market perspective characteristic of the United States approach to addressing international environmental problems. These flexibility provisions will substantially lower the cost of reducing emissions, create international commercial opportunities for our businesses, and minimize the creation of international bureaucracy. They build on our own domestic experience with market-based instruments in the reduction of other emissions (e.g., sulfur dioxide).

The Kyoto Protocol incorporates flexibility in almost all its elements. The Protocol, for example, establishes the initial compliance period as 2008-2012. This multi-year target provides flexibility for investment decisions of U.S. companies and smooths out fluctuations in annual weather and business conditions.

Further, all six major greenhouse gases are included in the agreement allowing countries to seek the lowest cost emissions across the range of greenhouse gases. Emissions and removals of greenhouse gases from reforestation, afforestation and deforestation are

included as part of the agreement, as are procedures for adding additional categories of sinks in the future. The opportunities for reducing emissions are thereby greatly expanded and the costs of compliance greatly reduced.

The agreement also provides great flexibility in the mechanisms for reducing the cost of emissions reductions while ensuring environmental compliance. Foremost among those are international emissions trading and Joint Implementation among countries with targets. One of the Administration's goals is to have these rules in place well before 2008. Emissions trading and Joint Implementation will provide access to those cheaper reduction opportunities for U.S. industry. In addition to lowering costs, the expanded commercial opportunities for U.S. firms will likely spill over into other areas helping to generate jobs for Americans.

Lastly, the protocol defines a Clean Development Mechanism (CDM) that allows U.S. firms to invest in projects in developing countries, which result in new emissions reductions. Some of the most inexpensive reduction opportunities worldwide are available in these developing countries. Further, some of the largest markets of the next century for U.S. goods are also in these countries. The CDM unlocks the door to those low cost reductions and provides an additional bridge to those markets.

Benefits and Costs of Addressing Climate Change

The Kyoto Protocol is a first step in reducing our exposure to a potentially serious environmental threat with unparalleled global implications. Without a change in the pattern of greenhouse gas emissions, the Intergovernmental Panel on Climate Change (IPCC) warns that average global temperatures will increase from current levels between 2 and 6.5 degrees Fahrenheit by the end of the next century. This would translate into average July temperatures in Washington, D.C., of 5 to 15 degrees F above current levels with even greater humidity. By comparison, average global temperatures during the last ice age were only 9 degrees colder than today. The IPCC also forecasts a sea level rise of 6 to 37 inches by the end of the next century. A 20-inch sea level rise would result in substantial loss of coastal land on the Atlantic and Gulf coasts, which are particularly vulnerable.

There are, of course, remaining uncertainties in the science, specifically for regional projections. DOE's scientists, including those at our national laboratories, are working to refine our scientific and computational capabilities in order to address these uncertainties. Nevertheless, this uncertainty should not cause policy paralysis or inaction. On the contrary, it is time for prudent, cost-effective responses and for the development of the technologies that will generate economic growth while reducing our risk from climate change.

Dr. Janet Yellen, Chair of the President's Council of Economic Advisers (CEA), testified before this Subcommittee on March 4, 1998 concerning the least-cost ways of reducing this exposure. Her testimony highlighted the substantial cost reductions that are associated with three of the flexibility mechanisms in the Protocol: International emissions trading, Joint Implementation by Annex I countries, and the Clean Development Mechanism.

While I am not an economist, allow me to repeat her main conclusions for context. She concluded that the costs would be modest for reaching the Kyoto objectives. Dr. Yellen traced potential cost reductions to three features of the flexibility mechanisms: (1) "when" flexibility provided by five year targets and banking opportunities; (2) "what" flexibility that allows countries to meet targets with a combination of reductions from six gases and sinks; and (3) "where" flexibility that allows emissions reductions to occur where they are the least expensive.

Dr. Yellen indicated that analysis suggests that with a successful worldwide trading regime for greenhouse gas emissions, the cost of emissions permits would be $14-$23 per ton of carbon equivalent. Total resource costs -- the cost of permits purchased abroad plus domestic reductions of greenhouse gases -- would be $7 to $12 billion per year, or 0.1 percent of projected GDP, during the first budget period of 2008 to 2012. The CEA does not foresee any significant aggregate employment effect under the conditions described in the analysis. Analyses that do not include international emissions trading, Joint Implementation and the Clean Development Mechanism suggest higher costs, reaffirming the importance of those flexible market-based instruments.

Dr. Yellen also noted the CEA analysis did not include estimates of the:

- cost savings from the Administration's electric restructuring plan (estimated at $20 billion per year) and the associated emissions reductions (estimated at 25-40 million tons of carbon equivalent per year);
- cost savings from land use changes that would increase carbon sequestration by forests and agriculture;
- benefits of avoiding the effects of climate change;
- benefits (e.g., health improvements) of reducing other pollutants such as sulfur dioxide and particulate matter; and
- significant technological improvement and penetration of these technologies into the domestic and global market place.

The Role of Technology

Technology R&D will not only enable us to meet the energy and environmental objectives of the next century, but also is a key driver of long-term economic development. The ability to develop and deploy new technologies in a wide range of

fields has been a key reason for the remarkable success of the U.S. economy in the last fifty years and will continue to drive our economic development over the next fifty years. Sustained commitment to R&D in both private industry and the federal government has produced these results. However, corporate downsizing, increased competition, financial pressures and other factors have drastically cut the level of private investment in R&D in many industries -- especially in energy. Without a substantial federal effort --in collaboration with industry -- many advanced technologies will likely not be developed and our nation will suffer the resulting economic losses.

A broad and balanced R&D portfolio -- one that builds on clean fossil, renewable and nuclear supplies and increased efficiency of energy use -- is essential. A robust energy portfolio will provide many additional benefits, including reduced energy costs, increased energy security, improved air quality, greater U.S. competitiveness, and reduced greenhouse gas emissions. The study of technology pathways carried out by eleven DOE national laboratories concluded that greenhouse gas emission reductions in the 150-200 million metric tons range of carbon equivalent are realizable by 2010 from technology development; much larger reductions would follow in the ensuing decades. Examples of promising technologies are:

- A fish friendly turbine that will help us preserve our large installed hydropower base that currently provides approximately 10 percent of U.S. electricity;

- Technologies that improve the efficiency and extend the operating life of current nuclear power plants that currently provide 20 percent of U.S. electricity;

- Super clean diesel engines that will be one-third more efficient than comparable gasoline engines and meet equivalent emission standards;

- Advanced gas turbines that can provide industrial and commercial buildings not only with their electricity, but with their heat, at system efficiencies of 70 percent and higher;

- R&D partnerships with the most energy-intensive U.S. industries -- like steel, chemicals, and forest products -- to develop technologies that save energy and increase industrial productivity;

- A new R&D collaboration with the agriculture industry to use crops like corn and soybeans -- instead of oil -- to make everyday consumer items, ranging from paints and plastics to carpets and car parts; and,

- Sequestration technologies to keep the carbon dioxide from coal combustion out of the atmosphere.

These technologies present opportunities to meet our economic, energy security and climate change goals simultaneously. Let me now turn to a more detailed look at key technology areas and sectors.

Efficient Use of Conventional Energy Options:

About 93 percent of the energy we consume today comes from fossil and nuclear fuel. Energy efficiency is not some "green" alternative to the "real business" of traditional energy investments; rather, it is grounded in better use of our dominant energy resources. The Department has a long-standing interest and investment program in energy-efficiency R&D. Advances in energy efficiency technologies offer the greatest near-term opportunity for securing environmental, economic and energy security goals. Important examples of the technologies we are working on in this area include: cogeneration, intelligent building control systems (that could increase new building efficiency by 50 percent), fuel cells joined with combined cycle plants, integrated gasification combined cycle power plants (potentially boosting power plant efficiencies to 65 percent), and transportation technologies through the Partnership for a New Generation of Vehicles (that will result in triple efficiency automobiles). I will amplify on these by sector.

Electric Utilities:

The range of carbon values identified by Dr. Yellen would be unlikely to affect electric utilities significantly. As is noted in the coal industry discussion below, new plant fuel choice and decisions regarding the dispatch of existing plants are likely to remain largely unaffected. Moreover, electric utilities do not compete to a significant extent with offshore suppliers. If carbon values were passed through into the prices of fuel burned at electric utilities, the cost of electricity would be increased relative to a "no commitments" forecast. However, even with full pass through, DOE expects the cost of electricity to remain below today's prices in real terms during the first commitment period. Furthermore, adoption of the Administration's Comprehensive Electricity Competition Plan, is expected to provide additional savings and cost reduction that would exceed the value of a full pass through of carbon values into fuel costs. That saving has been estimated to be in the neighborhood of $20 billion per year. In addition, greenhouse gas emissions will be reduced by 25-40 million metric tons of carbon equivalent as the industry becomes more energy efficient.

Coal:

The range of carbon values identified in Dr. Yellen's testimony would be unlikely to affect projections of future coal use significantly through 2008-2012. Natural gas is already the fuel of choice for new capacity additions, and most forecasts suggest that it is likely to remain so for the foreseeable future whether or not emissions values feed through into energy prices. With respect to the dispatch of existing steam and

combustion turbine plants, the order of economic dispatch would not appear to be significantly affected by estimated carbon values. Taken together, these two factors suggest modest impacts on coal use and mining during the 2008-2012 period.

Technology development and market penetration can particularly benefit coal-fired generation as the cleaner technologies under development will increase the efficiency with which coal is used, enhancing its cost competitive nature while minimizing carbon intensity. Advanced electric generation technologies are helping us lower greenhouse gas emissions from power plants. Recently, I visited Sierra Pacific's Piñon Pines project. Built under a 50/50 cost-sharing arrangement, DOE's Clean Coal Technology Program and Sierra Pacific Power Company dedicated the 100 megawatt integrated gasification combined cycle power plant outside Reno, Nevada. This plant will be 10 percentage points more efficient than a conventional coal-burning power plant and, as a result, will emit correspondingly fewer greenhouse gases. To provide a scale, we note that if all coal-fired power plants could achieve this rate of efficiency improvement, emissions would be reduced almost 100 million metric tons of carbon each year. The Piñon Pines project achieves this result while virtually eliminating sulfur dioxide and nitrogen oxides emissions.

Carbon sequestration is the removal of atmospheric carbon through natural or induced methods and is another technology option for coal (and indeed, for all fossil fuels) and is part of the President's Climate Change Technology Initiative. Research and development on this technology is at its early stages and large scale impacts are not anticipated for decades. Given that the vast wealth of U.S. coal resources surpasses the entire energy content of all of the world's known, producible oil, technology breakthroughs in sequestration could prove to be a major benefit for the domestic coal industry, for the creation of international markets, and for minimizing coal impacts on the environment, Capture of combustion gases, production of hydrogen from natural gas, use of micro algae to convert power plant CO_2 to biomass, injection of CO_2 in terrestrial aquifers (already being done to enhance oil and gas production), and oceanic injection of CO, are all examples of potential opportunities for enhanced sequestration as are modifications to agricultural and forestry practices. DOE has recently selected an initial group of twelve research projects to pursue the inexpensive capture and permanent disposal of greenhouse gases covering many of these opportunities.

Oil:

Impacts on domestic oil production would probably be modest. One thing we know for sure is that technology is helping us lower the cost of drilling and increase our energy resources. Research in the Alpine fields area of Alaska demonstrates that state of the art drilling and production methods can significantly reduce the environmental impact of oil and gas production. Earlier this year I had the opportunity to visit this site and came away very impressed by the small environmental footprint of this development project.

The Department is developing technologies that will decrease our oil consumption through innovation. The Partnership for a New Generation cf Vehicles (PNGV) -- a collaboration between the Federal government and the U.S. automobile industry -- is developing a production prototype car with a fuel efficiency of up to three times today's vehicles, or 80 miles per gallon by 2004, with no compromise in size, safety, affordability or performance. In January, Chrysler, Ford, and GM made news with their announcement of PNGV concept vehicles that promise two to three times greater fuel efficiency than available today. If these vehicles replaced only five percent of the current auto fleet, oil consumption would drop by almost one-quarter million barrels per day and carbon emissions would fall by about ten million metric tons.

In oil refining, advanced technologies are improving the quality of heavier crude oils. Research in ceramic membranes will provide improvements that can be used to increase the hydrogen content and improve product quality. Likewise, biochemical process research innovations can be used to improve the quality of heavier domestic oils such as those that are produced in California.

Natural Gas:

In contrast to oil, nearly all U.S. consumption of natural gas is supplied by North American sources. Many analysts believe that meeting the emissions targets for the United States would result in increased use, and domestic production, of natural gas.

A large potential exists for using natural gas more efficiently. Advanced gas turbines for industrial applications -- developed by the Department in partnership with private industry -- are nearly 50 percent more efficient than conventional small turbines. This technology can provide industrial and commercial buildings not only with inexpensive electricity, but with their heat, at total system energy efficiencies of 85 percent and with extremely low NOX emissions. This compares to efficiencies of around 40 percent today. Fuel cells are another extraordinarily promising technology that produces power and thermal energy electrochemically at very high efficiencies with virtually zero emissions. This exciting technology has enormous potential from power plants to our homes and offices to automotive propulsion systems. Just last week, Secretary Peña announced the first installation of a fuel cell in a home, by a company called Plug Power, where this fuel cell will produce electricity and allow the home to be removed from the electricity grid.

Last year, DOE awarded a cost-shared R&D contract to produce a revolutionary ceramic membrane for converting natural gas into a middle distillate liquid. If this research provides a substantially lower cost alternative to cryogenic oxygen separation, it would represent a major breakthrough for transporting natural gas. Alaska alone could then add a billion barrels or more of vital liquids to our energy supply.

Research on methane production from hydrates can contribute low cost natural gas to satisfy domestic demand. As much as 200,000 trillion cubic feet of methane may exist in hydrate systems in the U.S. permafrost regions and surrounding waters, which is over a hundred times greater than the estimated conventional U.S. gas resource base of 1,400 trillion cubic feet. The Department is engaged in ongoing research to determine the commercial viability of this resource.

We estimate that our natural gas technologies and policies will stimulate growth of low carbon natural gas production by as much as six trillion cubic feet by the year 2010 to fuel increased demand in electric generation.

Nuclear:

Nuclear power plants generate electricity without producing carbon dioxide, sulfur oxide, or nitrogen oxide emissions. This represents about 100 million metric tons of carbon emissions avoided annually. Consequently, the Department's FY 1999 budget proposal includes two modest initiatives aimed at sustaining nuclear energy as a viable option. First, the Nuclear Energy Plant Optimization program is the Department's response to the PCAST recommendation that the Department initiate a program of research aimed at operating nuclear power plants. The proposed program would develop the technologies needed to improve capacity factors of existing U.S. plants and to extend their useful lives. Second, the Nuclear Energy Research Initiative is a program that features an independent, competitive, peer-reviewed process for selecting from among investigator-initiated R&D proposals. This program will fund work in areas such as advanced nuclear fuel, proliferation-resistant reactor systems, and least-cost, advanced power systems.

Renewables:

Renewable energy technologies have substantial potential to produce low-cost electricity with virtually zero emissions using plentiful U.S. energy resources. Steady R&D progress over the last 15 years has brought the costs of solar photovoltaics, wind, geothermal, biomass and other technologies down by factors of 5 to 10. These technologies are already finding their way into selected markets and are poised to increase their market share. For example, wind power now costs less than 5 cents per kilowatt-hour in favorable wind sites and is the focus of increased attention in many electric utilities. These technologies provide power with minimal environmental impacts, have low or zero greenhouse gas emissions and will allow American industry to be very competitive in the trillion dollar global market for clean energy technologies over the next several decades.

According to the recently completed study conducted by eleven of our laboratories, biomass, wind, solar, and geothermal technologies may reduce U.S. carbon emissions in the range of 100 million metric tons by 2030.

Recently, Mayor Giuliani and Secretary Peña celebrated a new state of the art office tower in Manhattan -- a building already fully rented, powered in part by fuel cells and photovoltaic panels, and expected to be 40 percent more energy efficient than the average building its size, with a similar reduction in associated greenhouse gas emissions. DOE developed the technologies used in this building in partnership with industry and the national laboratories. This points out that the technologies we are discussing are real alternatives that can be expected to be used more widely over the next decades.

Conclusion

These are just some examples of the role DOE can play. Clearly, the common ground in the climate change debate is technology. From Mobil Oil to the Sierra Club, there is agreement that substantial industry and government support for energy R&D is a key element of an effective and prudent response to climate change, independent of opinions about the science or diplomacy of the issue. Last year, a peer-reviewed study conducted by five national laboratories recognized that the United States can hold down the costs of meeting climate change goals by developing clean energy technologies. In fact, the study concluded that significant progress in reducing greenhouse gas emissions could be achieved without increasing the nation's total energy bill. More recently, eleven national laboratory directors issued a study that outlined almost 50 separate technology pathways for reducing greenhouse gas emissions over the next 30 years while providing other energy, environmental, and economic benefits. We hope to work with the Congress in a bipartisan spirit to advance the nation's basic and applied research programs.

A strengthened energy science and technology program, together with synergistic tax incentives for accelerated technology introduction, is an important first step with multiple benefits for America. A *Washington Post* editorial on the Administration's FY 1999 budget-proposal put it this way:

> "...this [global warming] proposal would make sense whether Kyoto ever comes into force or not. Most of the initiatives would spur industry toward pollution-reducing measures that will benefit the country and make industry more competitive in the long run. Indeed, those who oppose binding commitments, trading permits, increased fuel taxes and more regulation should, more than anyone else, embrace measures that might produce progress without coercion."

Finally, technology is a key to ensuring the meaningful participation of developing nations in a climate treaty. It is technology that will provide developing nations with the ability to grow their economies, and at the same time limit their greenhouse gas emissions

and reduce the traditional air pollutants. Over the next four decades, developing countries alone will require new electricity generating capacity worth more than $3 trillion. In order to meet this energy demand and reap the resulting technology sales and jobs, we must invest now in the research, development, and demonstration of energy technologies. U.S. companies and workers can have the largest piece of this huge market if we win the R&D race. But, if our commitment to energy technology R&D is stalled, then the U.S. economy, our citizens, and the global environment will be the real losers.

Thank you and I will be pleased to answer your questions.